'Firefly' test aims to shed light on COVID-19 vaccine endurance

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Igor Stagljar (left) and Zhong Yao (right) who developed a new test for COVID-19 antibodies using a version of the enzyme that allows fireflies to give off light.

HANDOUT

In the effort to find a reliable way to measure immunity to COVID-19, a Canadian-led research team has enlisted an unusual ally: fireflies.

The light-emitting insects – or rather, the enzyme that enables them to glow – is the inspiration behind a blood test that measures the presence of antibodies that defend against the coronavirus with a flash of light.

The test's inventors say their solution is both faster and cheaper than what is currently available to medical laboratories. It also has the required sensitivity to reliably probe how an individual's antibody levels are changing over time – a measurement that may prove important for determining when someone who has been vaccinated or previously infected by COVID-19 is no longer protected.

"Such information could be crucial during the next stage of the pandemic," said Igor Stagljar, a molecular biologist at the University of Toronto whose team developed the test. A description of the work was published Monday in the journal Nature Communications.

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Dr. Stagljar said the effort began after Zhong Yao, a research associate in the lab and a native of Wuhan, China, returned from a trip to visit family in early January of last year and told colleagues of an emerging disease in his home city that was, at that point, just about to begin making international news.

As the nature of the illness and its link to a novel coronavirus become clear, the researchers decided to develop a test to detect antibodies that block the virus. The group's tool of choice was a modified form of luciferase – the aptly named enzyme that gives fireflies their light-emitting power through a biochemical reaction.

Commercial versions of the enzyme are now widely used in biotechnology. The University of Toronto team opted for a method developed in 2017 by Shawn Owen, a collaborator at the University of Utah, which involves splitting the enzyme into three parts.

In its experiment, the team engineered the parts so that one came attached to the coronavirus spike protein, while a second was attached to a different protein that has an affinity for antibodies. When an antibody is present that is capable of attaching itself to the coronavirus spike protein, the interaction brings together the two pieces of the luciferase enzyme. The third part is also added to complete the reassembly and then the enzyme regains its ability to generate light.

"The antibody helps lock the luciferase pieces together into a whole molecule," Dr. Stagljar said. "Then a flash of light occurs."

The intensity of the flash produced when the pieces are added to a blood sample can be measured with a device called a luminometer and then turned into a reading of antibody levels in the blood.

The team was able to validate a prototype of its test last summer with a dozen blood samples from COVID-19 patients at Sunnybrook Health Centre in Toronto and then more recently with over 90 samples provided by Canadian Blood Services.

Dr. Stagljar said the test can be performed in under one hour for a cost of about $2 per sample, far less than the cost of the test that is the current standard for measuring COVID-19 antibodies. Negotiations are now underway with various companies that are looking to commercialize the technology, he said

While others have employed luciferase in pursuit of a COVID-19 antibody test, the University of Toronto team is the first to publish its results.

What remains to be seen is whether the test will prove itself useful in the long-term investigation of immunity to the virus that causes COVID-19.

Mel Krajden, medical director of the BC Centre for Disease Control public health laboratory and a member of Canada's immunization task force, said that while the luciferase test may use a novel method, the most urgent question experts face is not the cost of testing but in understanding the link between antibodies and protection.

"The reality is there [are] a lot of tests that are out there," he said. "Right now the challenge is understanding, if you're vaccinated, what is the durability of that protection?"

Allison McGeer, a senior clinician-scientist at Mount Sinai Hospital in Toronto said she is currently working on a number of post-vaccination studies and is providing samples to Dr. Stagljar's team to help further develop and validate the luciferase test.

"We are interested in effectiveness and duration for different vaccines in different population subgroups," Dr. McGeer said.